8 Relevant Literature

8.1 Compendium of Weekend Effect Literature

Below is a summary of the literature on the subject of the weekend effect. Due to time constraint, some of the papers have not been summarized; they are indicated with an asterisk (*) in the first column.

Paper No.	*Paper Title*	*Author(s)*	*Published*	*Data Analyzed*	*Method(s) Used*	*Conclusions*
1	Sunday and Workday Variations in Photochemical Air Pollutants in New Jersey and New York	Cleveland, Graedel, Kleiner, & Warner; Bell Laboratories	1974 *Science* V. 186	May-Sept. 1972-73, Sunday and workday (Mon-Fri) NO, NO_2, SO_2, aldehydes, CO, THC, CH_4, NMHC, aerosols, O_3, visible solar radiation, UV solar radiation, wind speed, wind direction, mixing height, temperature, s.d. of vertical wind direction, s.d. of horizonal wind direction, and precipitation, averaged from 5 a.m. to 1 p.m. (except O_3 is max hrly avg from 11 a.m. to 6 p.m. and 7 a.m. to 8 a.m.; precipitation is daily total; mixing height 7 a.m. reading; temperature daily max, min, and avg)	To compare distribution of Sunday values of a variable at a site with that of workday values. Quantile-quantile (Q-Q) plots.	Aldehydes and CH_4 slightly lower on Sundays. SO_2 no consistent pattern. O_3 maxima slightly higher on Sundays; O_3 averages much higher. Solar radiation, mixing height, and vertical sigma: higher Sunday quantiles; all other meteorological variables, workday and Sunday quantiles similar.

2	Weekday vs. Weekend Oxidant Concentrations	Kinney; CARB	1974 *CAQD* V. VI N. 3	1966-70 oxidant concentrations in SoCAB	compared spatial distribution of WE Effect by season	occurrance decreased with distance inland; Effect occurred during most months in coastal area and less than half of the months at sites inland. WE Effect covered most of SoCAB during Qtr 1 but only in coastal area during Qtr 3 (July-Sept)
3	Weekday vs. Weekend Oxidant Concentrations II	Kinney; CARB	1974 *CAQD* V. VI N. 4	mid-June - mid-Sept composite of Oxidant @ Pomona, San Bernardino, & Riverside and 4a.m. temperature aloft (5000')	9-year means of oxidant, 5000' temperature, & met-adjusted oxidant	in peak oxidant area of SoCAB, concentrations lowest on Sunday & increase to peak on Wed-Fri before dropping on weekend; when met-adjusted, small drop in [Ox]s from Fri to Sat
4	A Comparison of Weekend-Weekday O_3 and HC Concentrations in the Baltimore-Washington Metropolitan Area	Lebron; Maryland Dept of Transportation	1975 *AE* V. 9	June-Sept. 1972-73, hrly O_3 from 11 EST for 8 hrs, avg 0600-0900 HC, all 7 days.	"Smog Index" = sum of squares of amount over 4pphm for each hrly O_3. Grouped weekday and weekend avgs. Kruskal-Wallis ANOVA tests equality of means. Linear regression of peak O_3 on HC on afternoon of same day.	No day of week has significantly higher "smog index". Weekend Index not different from weekdays. Weekdays HC higher than weekends HC. No relationship between O_3 and HC. Thus control strategies based solely on reduction of 0600-0900 HC emissions may not effectively reduce O_3.

5	Weekday-Weekend Pollutant and Meteorological Studies of the Los Angeles Basin	Levitt & Chock; General Motors Research Labs	1975 APCA Paper 75-51.1	June-Sept., 1972 & 1973: Ox, NO, NO_2, THC, CO, PM plus Solar Radiation, Rel. Humidity, and Temp.	Percentiles for each hour. Kolmogorov-Smirnov test for significant differences. Daily maxima.	All sites: NO_2, PM, HC, NO, CO lower on weekend. Group 1: New(Lhall, Burbank, Reseda higher weekday Ox. Group 2: LA, WLA, Pasadena, Azusa, Pomona similar. Group 3: Lennox, Long Beach, Whittier higher weekend Ox. Lennox, L. Beach, Whittier have higher weekend daily maxima; all others indistinguishable.
6	Weekday-Weekend Pollutant Studies of the Los Angeles Basin	Levitt & Chock, General Motors Research Labs	1976 *JAPCA* V. 26	June-Sept., 1972 & 1973: Ox, NO, NO_2, THC, CO, PM	Percentiles for each hour. Kolmogorov-Smirnov test for significant differences. Daily maxima.	All sites: Oxidant higher on weekends than weekdays prior to 0900 am, due to NO being an ozone scanvenger => not consistent w/ smog chamber results. North region (Newhall): weekday ox higher than weekends at 0.10 level; Central region (Los Angeles): low ox differs insignificantly; South region (Lennox): no difference.

7	Photochemical Air Pollution: Weekend-Weekday Differences	Elkus & Wilson; Dept of Chemistry, UC San Diego.	1977 *AE* V. 11	Avg hrly concentrations of CO, NO, NO_2, RHC (THC - methane), and Ox. 1965-1972, except for some sites, from LAAPCD; Traffic count data from Caltrans.	Daily profile of CO, NO, NO_2 and Ox. Hr by hr weekly patterns of CO and Ox. 24-hr avg pollutant levels for each day of week at 10 stations. Avg daily hrly maximum for Ox. Autocorrelation (to test that measurements made 1 week apart are independent). Fractional change bet. WkDay and WkEnd = (WE - WD)/WD; then take median.	1) CO, NO, RHC high near midnight, drop early morning, then peak 8 AM on weekdays, then rise again late afternoon. NO2 similar to NO & CO, except peak is later. Ox similar. 2) WkEnd and wkday structures for CO differ; Ox shows temporal pattern almost independent of day of week. 3) WkEnd drop in annual daily avg CO, NO, RHC, and NO_2 while avg Ox levels rise on weekends. 4) Large fractional decrease of pollutants on weekends at 95% level (at most stations). 5) Significant increase in Ox on weekends at 95% level (at most stations), but decrease at inland stations. 6) Traffic is 20% lower on weekends than weekdays. Conclusion: Care must be taken when designing short-term Ox control strategies. Controls which mimic weekend emissions changes would be ineffective if applied to random days.
8*	Photochemistry of the “Sunday Effect”	Graedel, Farrow, & Weber	1977 *ES&T* V. 11			

9	Weekday-Weekend Ozone Concentrations in the Northeast United States	Cleveland & McRae; Bell Laboratories	1978 *ES&T* V. 12	28 sites (NJ, NY, CT, MA): O_3, May-Sept. 1974-75 at 21 sites, 73-75 at 6 sites, 70-75 at 1 site. 10 sites: hrly CO, May-Sept. 1974-75. Traffic counts between NJ and NY, May-Sept. 1974-75.	Empirical quantile-quantile (EQQ) plots. Upper quarter means. Time series with periodic means, variances and autocorrelations (of square root daily maximum O3)	O_3 reduced on weekends and Monday, then gradually increased on Tues to Fri.; same for traffic patterns. (Possible) Traffic reduction causes Monday O_3 reduction. For weekend vs Tues-Fri: CT sites, large O_3 reductions on weekend; MA sites, moderate to slight reductions; NY, NJ sites, little change.
10	Day of Week Variations of Photochemical Pollutants in the St. Louis Area	Karl; US EPA	1978 *AE* V. 12	25 sites grouped into inner, transitional, and outer categories based on pollutant concentrations, distance from downtown and emission patterns of THC and NO_X. Ox, NO, NO_2, THC, surface temp., wind speed.	Descriptive statistics. Diurnal plots.	Difference in concentrations of NO, NO_2, NMHC, and O_3 from Sundays to workdays depended on distance of the measurement from the urban area. O_3 decreased from Sundays to workdays inside the city. Meteorological conditions not responsible for these differences. (Possible) NO increase from Sunday to workdays lead to O_3 decrease on workdays inside the city.
11*	On the Weekday-Weekend Oxidant Differences in the California South Coast Air Basin	Chock & Pierson; GM	1978 GMRL Pub. 2799			

12	Ozone Episode Experience in the South Coast Air Basin	Mulberg; CARB	1978 *CAQD* V. X N. 1	1964-77 Stage II & III oxidant episodes in SoCAB	frequency by day-of-week	Stage III Episodes monst frequent on Thur. and non-existent on weekend; Stage II Episodes fewest on Sun, increasing during week to peak on Fri.
13*	Carryover: The Impact of Aged Pollutants on Air Quality	White	1978 manuscript			
14	Weekend/Weekday Differences in Oxidants and Their Precursors	Horie, Cassmassi, Lai, & Gurtowski; Technology Service Corporation	1979 EPA-450/4-79-013	May-Sept. 1973-76, Washington D.C., Baltimore, Philadelphia, New York-Newark, and Boston. ambient pollutants at 22 sites (no rural); surface meteorological observations at 12 sites; upper-air meteorological measurements at 3 sites.	1) *normal* WE/WD: weekends as Sat, Sun; weekdays as Mon-Fri. 2) *Sunday* WE/WD: weekends as Sun; weekdays as Tues-Fri. t-test & visual test of box displays. Meteorological adjustments using tree classifications. Ox, precursors NO, NO_2, NO_2/NO_X, NMHC, THC. 95% CI for median. Wilcoxin rank sum test for NO_2/NO_X ratio difference.	Among 22, 3 sites show consistently significantly lower Ox on weekends. %change (WE-WD) larger for Sunday vs Tues-Fri than for Sat-Sun vs Mon-Fri. Most important meteorological variables to explain daily max Ox: daily max temp., visibility, wind direction, mixing height (using 'tree'). Among 8, 5 sites show significantly lower 6-9a.m. avg NO on weekends. Among 4, 2 sites sign. lower 6-9a.m. NMHC and THC weekends under *Sunday* WE/WD definition; all sign. lower weekend level under *normal* WE/WD definition. (Possible) Simultaneous control of NO_X and NMHC less effective than HC control.

15*	Response to: A statistically tested short-term oxidant control strategy	Chock & Pierson	1980 *AE* V. 14			
16	Weekday/Weekend Differences in Diurnal Variation in CO, NO_2, and Ozone - Implications for Control Strategies	Hoggan, Hsu, Kahn, & Call; SCAQMD	1989 AWMA Paper 89-125.5	Diurnal: CO, NO_2, O_3, SO_2, NMHC, NO for 1985-87, 82-84, 78-80. Day of Week: PM10.	t-tests for equality of Saturday vs. M-F means and Sunday vs. M-F means of daily max 1-hr average and 24-hr average, using Bonferroni adjusted significance levels. Mean #exceedances of AAQS by day of week for diurnal concentrations of criteria pollutants.	CO and NO_2: mean #exceedances of AAQS for Sat and Sun lower than for Mon-Fri. O_3: though NO_X and NMHC lower on weekends, O_3 slightly higher on weekends for most sites, sensitive to precursor concentrations, their spatial and temporal distributions, HC/NO_X ratios, and sunlight intensity by PM10. Need further study. Traffic data suggests time and place of controls on pollutant emissions are important.
17	An Analysis of Weekend/Weekday Differences in the South Coast Air Basin of California	Zeldin, Horie, & Mirabella, Southern California Edison	1989 AWMA Paper 89-125.6	May-Oct. 1984-86, daily max 1-hr avg O_3, avg 0500-0800 hrly NO_2 and NO_X.	t-tests for differences between Sat, Sun, Mon and 'typical' weekday (Wed, Thurs) Carryover effect: NO_2/NO_X ratio. Basin divided into 6 geographic regions: Coastal, Metro, San Gabriel Valley, Inland, Inland Valley, and Mountain.	Coastal and Metro: O_3 higher on Sat and Sun. S. Gabriel Valley: O_3 highest on Sat, Sun differ from weekday. Inland: O_3 insignificantly higher on Sat. Inland Valley and Mountain: improved O_3 on Sun., lower O_3 on weekends. Thus O_3 results consistent with airshed models. Coastal and Metro: lower NO_X on weekends. NO_2/NO_X ratios: highest on Sundays, about same on Sat and weekdays.
18*	Analysis of ozone air	Rao, Sistla,	1991			

	quality over the New York metropolitan area	Schere & Godowitch	in Air Pollution Modeling & its Applications VIII Plenum Press			
19	Weekday vs. Weekend Ambient Ozone Concentrations: Discussion and Hypotheses with Focus on Northern California	Altshuler, Arcado, & Lawson	1995 *JAWMA* V.45	Mean hourly ozone, NO_2, and CO: 1981, 1982, 1991, 1992. Emission inventory of ROG, NO_X: 1980, 1990.	Diurnal plots. Percent change in emissions. EKMA diagrams.	In Northern CA, weekend effect is stronger in the 1990s than in the 1980s. Weekend effect combined w/ changes in emissions could provide a clue to whether an area is NO_X or ROG limited wrt ozone formation.
20*	Effect of alternative boundary conditions on predicted ozone control strategy performance: a case study in the Los Angeles Area	Winer, Cass, & Harley	1995 *AE* V. 29			
21	Characterization of ozone episodes in SoCAB: Effects of air parcel residence time and we/wd differences	Blier, Winer, Hansen, & Verma	1996 ARB Contract 93-316	O_3, CO, NO_2, NO_X, TSP, Met, & NO 1986-1993	Correlation Contrast, Air Parcel Residence Estimation, Trend Analysis, Multi-Linear Regression, CART SoCAB	O_3-NO_2 & O_3-NO_X Differences between 86-89 & 90-93 O_3 Reduction Trend at all times all days of the Week Max % Decrease in NO_X Areas had the largest improvements for the worst O_3 Episodes

22	An analysis of the weekday-weekend behavior of ambient concentrations of ozone and its precursors	Tran, Larsen, & Austin	1996	(draft manuscript, superseded by Austin and Tran, 1999)		
23	Day of week contrasts for ozone, NOx and CO	Hemphill & Sullivan	1997	(draft to be sent later)		
24*	PAMS Data Analysis: An investigation of local meteorological effects on ozone during OTAG 1995 episode and wd/we differences in the Northeast Corridor	Vukovich	1997 SAIC report to EPA OAQPS			
25*	Weekend-Weekday Differences of Near-Surface Ozone Concentrations in Switzerland for Different Meteorological Conditions	Bronnimann & Nue	1997 *AE* V. 31			

26	A fuel-based inventory for heavy-duty diesel truck emissions	Dreher & Harley	1998 *JAWMA* V. 48	Daily traffic (W.I.M.) counts by vehicle class (light-duty vehicles and diesel trucks)	Ratio of daily total to weekly avg traffic counts by vehicle class, for each day of week. Hourly count as a percentage of total daily count.	HD vehicle travel declined from weekdays to weekends. Decreases on off-road mobile source and stationary source activity may contribute to differences. Changes in exhaust emissions due to reduced diesel truck activity may lead to lower fine PM on weekends. Lower fine PM emissions from diesel trucks may lead to increased photolysis rates and ozone formation on weekends.
27	Seasonal and weekly pattern of ozone over the OTAG region	Husar	1998 AWMA Paper 98-MPB.06P	1986-1995 daily max-hr O_3 in OTAG region	50^{th}, 75^{th}, 90^{th}, 95^{th} percentiles of OTAG-wide averaged O_3 by day-of-week; exceedances of 120 ppb	no weekday pattern at 50^{th} %ile, weak at 75^{th} %ile, but apparent at 90^{th} & 95^{th} %iles. O_3 lower on weekends than weekdays (2ppb effect); O_3 lowest on Sun, increasing Mon & Tues, ~ constant Wed - Fri, declining on Sat & Sun.; exceedances of 120ppb much less frequent on Sun than on Fri.
28	A preliminary study of the weekday/weekeend differences in ozone and its precursors in large urban regions and their implications toward control strategies	Vukovich, Jeffries, & Guinnup	1998 EPA Draft	Hourly O_3, NO_X, VOC, NMHC: weekday vs weekend. June-July, 1995. Washington DC, Philadelphia, New York, Houston	Sum of 3 hourly values. Average across sites. Diurnal profiles. Exceedances.	Weekend O_3 higher on weekend than weekday while NO_X higher on weekdays. Reductions in NO_X and VOC may have a localized disbenefit effect on ozone, especially on ozone-conducive days. Differences in emission inventory between wd and wk day must be quantified in order to evaluate air quality models.

29	Analysis of Weekend-Weekday Differences in Ozone and Ozone Precursors in the South Coast (Los Angeles) Air Basin	Stoeckenius, Taylor, Yarwood, & Lee, ENVIRON	1998	(see response, item #30, below)		
30	Response to Environ's Report	ARB	1998 ARB LEV II staff report Appendix I			The simultaneous occurrence of higher ozone on weekend and lower NO_X emissions do not prove the disbenefit of control strategies, given the reduction in ozone on all days of week.
31	Evaluation of recent NO_2 and ozone levels in Southern California on weekdays and weekends using EPA AIRS data: Implications for the LEV II proposal	Darlington & Kahlbaum; Air Improvement Resource	1998 Report to Navistar	Trends in HC and NO_X inventories, SC. Trends in O_3 and NO_2: weekdays & weekends, 1986-1998. Vehicle activity by day of week, to assess correlation with changes in O_3 and NO_2.	Avg max 1-hour ozone and NO_2; 8-hour avg O_3. By day of week.	1. Ambient NO_2 and ozone down since late 1980s. 2. MV program reduced ambient HC significantly. 3. Ozone increased on weekends, showing a region is at a lower VOC/NO_X ratio. 4. Ambient NO_2 reduction appears to cause the O_3 increase during weekends. 5. Further reduction in NO_X and NO_2 w/o reductions in ambient HC will make it more difficult to lower ozone.

32	Analysis of weekday/weekend differences in air quality and meteorology in SoCAB	Blier & Winer	1999 ARB Contract 95-334	O_3, CO, NO_2, NO_X, NMHC, VOC, RWP-RASS, PM10, PAMS, Temp, RH, Aerosols, & NO 1986-1996	High & Middle O_3 Episode Investigation, Gridded Met Analysis, Correlation Contrast, Trend Analysis, SoCAB	O_3 Reduction Trend at all times all days of the Week O_3 Season Shorter & Shifted Forward Modest Surface Carryover 1994-95 NO_X & NMHC Reduction Sat-Sun but Sun lower O_3 than Sat
33	A characterization of the weekday-weekend behavior of ambient ozone concentrations in California	Austin & Tran	1999 7th Intl Conference on Air Pollution; Palo Alto, CA	Daily max 1-hour ozone, May 17 - October 15, 1992-1998. South Coast Air Basin, San Francisco Bay Air Basin, and Sacramento Valley.	Adjust for effects of meteorology and outliers: fit smooth curves and analyze residuals (adjusted concentrations). Use principal components to view results and categorize behavior. Test for significant day-to-day changes in ozone at 5% level.	1. Typical pattern for weekend effect: increase from Friday to Saturday, slight increase from Saturday to Sunday, then decrease on Monday. 2. Weekend effect strong at urban sites in South Coast and San Francisco Bay, less prominent at sites far downwind from emission sources; stronger post-CBG (1996-1998) compared to pre-CBG (1992-1994 or 1995) 3. It does not exist in Sacramento Valley.
34*	Spatial mapping of VOC and NO_X - Limitation of Ozone Formation in Central California	Blanchard & Fairley	1999 manuscript			
35*	Sensitivity Analysis of Weekday/Weekend Differences in Photochemical Air Pollution	Vuilleumier	1999 PERF paper			

* paper not yet summarized.
AE = Atmospheric Environment
APCA = Air Pollution Control Association
AWMA = Air & Waste Management Association
CAQD = California Air Quality Data quarterly report
ES&T = Environmental Science & Technology
GMRL = General Motors Research Laboratory
JAWMA = Journal of the Air & Waste Management Association
JAPCA = Journal of the Air Pollution Control Association
PERF = Petroleum Environmental Research Forum